MCR-76-279-A
Contract NAS8-31689

AMPS Supporting Research and Technology (SR&T) Report

DR-SE-243B

November 5, 1976

Atmospheric, Magnetospheric, and Plasmas in Space (AMPS) Definition Study

MARTIN MARIETTA

Bendix

NASA CONTRACT
NAS8-31689

MCR-76-279-A

AMPS SUPPORTING RESEARCH AND TECHNOLOGY (SR&T) REPORT

DR-SE-243B

November 5, 1976

ATMOSPHERIC, MAGNETOSPHERIC,
AND PLASMAS IN SPACE (AMPS)
DEFINITION STUDY

Prepared For

Goddard Space Flight Center
Greenbelt, Maryland 20771

J. T. Keeley
Program Manager
AMPS

Martin Marietta Corporation
Denver Division
Denver, Colorado 80201

FOREWORD

The AMPS Supporting Research and Technology (SR&T) Final Report is submitted in accordance with Data Requirement SE-243B of Data Procurement Document No. 486, Contract NAS8-31689.

SUPPORTING RESEARCH AND TECHNOLOGY
(SR&T)

ATMOSPHERIC, MAGNETOSPHERIC, AND PLASMAS IN SPACE
(AMPS)

TABLE OF CONTENTS

Tables

GLOSSARY OF TERMS

RESEARCH

The activity involves study of current state-of-the-art science and engineering for application to the particular problem area being investigated.

ADVANCED TECHNOLOGY

The activity involves an advance in the state-of-the-art in science or engineering techniques; however, any hardware effort does not go beyond that required to demonstrate the validity of the advanced technology.

ADVANCED DEVELOPMENT

The activity involves development of systems, subsystems, or components which are recognized as having long development times. These hardware items may be of current state-of-the-art or advanced state-of-the-art resulting from an advanced technology study.

SUPPORTING DEVELOPMENT

The activity develops (1) backup or alternate systems, subsystems, components, and (2) fabrication, cost and evaluation techniques. Advances in the state-of-the-art may or may not be incorporated as appropriate. The product of this activity is hardware or techniques suitable for replacing their primary counterparts in the major development effort being supported.

1. INTRODUCTION

This document provides the NASA for its consideration a listing of candidate technology areas that require additional study. These candidate tasks, identified during the AMPS Phase B studies, are requisites to the design, development, and operation of the AMPS concept selected for preliminary design.

The criteria for selecting a candidate items is its technical merit. It must show promise of improving the hardware or mission, or pose barriers to design and development of end items. There must be a reasonable expectancy of success for the task in the sense of having beneficial application (i.e., improved performance, lower cost, or improved schedules).

The potential SR&T tasks identified as a result of the preliminary design effort will be reported in one of the following categories:

1) Systems - This category consists of three subcategories and associated technology areas.
   a. Operations - Mission operations, flight operations, software, crew systems, simulations.
   b. Verification - Instrument Design and Development, payload integration and checkout.
   c. Systems Analysis - Contamination, electromagnetic environments analysis.
2) Subsystems/Disciplines - This category includes five subsystem disciplines and associated technology areas.
   a. Structural/Mechanical - Structural and mechanical analyses, weight, center of gravity.
   b. Thermal - Thermal control systems, cryogencis.

c. Support Subsystems - Electrical power and distribution, data management, communications, controls and displays, instrumentation, caution and warning.

d. Pointing Subsystems - Attitude and pointing control, stability.

e. Deployed Instrument Support - Subsatellites, tethers, booms, ESPs.

3) Instruments - This category includes technology requisites associated with design of individual instruments. The three subcategories correspond to the IFRD instrument groupings.

a. Active Instruments

b. Passive Optical Instruments

c. Passive Plasma Instruments

4) Science Support - The science support technology category includes those tasks primarily related to either the basic science or the operational aspects of the identified experiments and instruments. This includes ground and systems related data and operations to satisfy experiment requirements. The two subcategories are:

a. Atmospheric Physics

b. Magnetospheric and Plasma Physics

This document is divided into four sections corresponding to these four SR&T categories. The first page of each section contains a summary table of the candidate tasks that have been identified for that particular SR&T category. Also included is a recommendation for each task as to whether it is required prior to or during the AMPS Program design and development phase (Phase C).

The remainder of each section presents individual data on each candidate tasks in the following format:

(1) Task Title;

(2) Status;

(3) Justification;

(4) Technical Plan (Objectives and Approach);

(5) Resource Requirements (Manpower, Facilities, Funding);

(6) Target Schedule.

2. SYSTEMS

Table 2-1 summarizes the candidate SR&T tasks identified for the systems category and individually discussed in this section.

SUBCATEGORY	TASK		SCHEDULE	
			PRE PHASE C	PHASE C
(2.1) Operations	(2.1.1)	AMPS Operational Support Software Requirements - Evaluation and Definition.	X	
	(2.1.2)	AMPS Software Development Concept	X	
	(2.1.3)	Payload Experiment Operation Logging System.		X
(2.2) Verification	(2.2.1)	Guidelines for Selection of AMPS Verification Programs.	X	
(2.3) System Analysis	(2.3.1)	Electromagnetic Compatibility	X	
	(2.3.2)	Methods to obtain orientation knowledge for instruments.		X
	(2.3.3)	Spacecraft Charging and Meutralization Mechanisms.	X	
	(2.3.4)	Orbiter/Spacelab Environment Definition.	X	
	(2.3.5)	Experimenter/Computer Dialogue Development.	X	

TABLE 2-1 SYSTEMS SR&T TASKS

2.1 OPERATIONS

NUMBER: 2.1.1	PROPOSED SR&T TASK	DATE: 11/5/76

TITLE: AMPS OPERATIONAL SUPPORT SOFTWARE REQUIREMENTS EVALUATION AND DEFINITION.

STATUS:

- [ ] RESEARCH
- [X] ADVANCED DEVELOPMENT
- [ ] ADVANCED TECHNOLOGY
- [ ] SUPPORTING DEVELOPMENT

JUSTIFICATION: It has become apparent during the conduct of the AMPS Phase B studies that there is little consensus as to the detailed requirements of the various elements of AMPS support software. Requirements to be met by the total system are generally understood, but the division of responsibilities between ground and flight, the interfaces to be mechanized with the experimenter prior to flight, with the flight crew and with the mission operations team are not agreed upon. Further, the details of data handling requirements of proposed experiments are sparce to the point of making it impossible to adequately define the characteristics of the supporting software system. A definition activity is required to formulate a consensual approach.

TECHNICAL PLAN:

OBJECTIVE: Generate a complete and consistent AMPS Software Requirements Document that defines system level requirements and detailed subset functions/characteristics to be implemented in the AMPS software packages.

APPROACH: Definition activity comprises three phases, two of which are covered here. Phase I involves data/requirements collection from the experimenters defining candidate AMPS payloads, and the organizations responsible for experiment conduct and data acquisition. Phase II analyzes these data and generates consistent software requirements. This phase will use the Problem Statement Language/Problem Statement Analyzer developed by the University of Michigan, and currently installed at MMC. The final phase (beyond current scope) is the review, revision and maintenance of resulting documentation.

RESOURCE REQUIREMENTS:

MANPOWER: 3 Man Years/15 Hrs IBM 370 Time

FACILITIES: IBM 370 Computer

FUNDING: ~$165K

TARGET SCHEDULE: Pre Phase C

NUMBER: 2.1.2	PROPOSED SR&T TASK	DATE: 11/5/76

TITLE: AMPS SOFTWARE DEVELOPMENT CONCEPT

STATUS:

- [X] RESEARCH
- [ ] ADVANCED DEVELOPMENT
- [ ] ADVANCED TECHNOLOGY
- [ ] SUPPORTING DEVELOPMENT

JUSTIFICATION: Various elements required for the development of AMPS software (computers, operating system software, interpretive computer simulations, compilers, laboratory facilities, et al) are being developed by NASA and ESA in support of STS and Spacelab. These developments are proceeding without AMPS applications requirements specifically in mind. The combination, location and data interfaces between available (and newly identified) elements must be planned to facilitate meeting AMPS requirements. Concise early planning will assure timely availability of low cost AMPS support software.

TECHNICAL PLAN:

OBJECTIVE: Define the procedures, hardware/software elements, and data interfaces required to develop and validate AMPS operational software.

APPROACH: Using the requirements definition evolved in 2.1.1, conceptualize candidate software development (design, build and test) plans and the arrays of hardware and software elements and laboratory facilities required to support them. Conduct evaluations of the candidate approaches, ranking them in terms of such parameters as new element requirements, experimenter interface flexibility, cost effectiveness, skill requirements, et al. Based on these evaluations, select and define the recommended approach.

RESOURCE REQUIREMENTS:

MANPOWER: 2.5 Man Years

FACILITIES: None

FUNDING: TBD

TARGET SCHEDULE: Pre Phase C

NUMBER: 2.1.3	PROPOSED SR&T TASK	DATE: 11/5/76

TITLE: PAYLOAD EXPERIMENT OPERATION LOGGING SYSTEM

STATUS:

- [X] RESEARCH
- [ ] ADVANCED DEVELOPMENT
- [ ] ADVANCED TECHNOLOGY
- [ ] SUPPORTING DEVELOPMENT

JUSTIFICATION: The AMPS data requirements encompass accumulation of digital, analog, video, photographic, crew observation plus orbiter attitude, state vector data. A smooth data reduction program requires the above data in compact form plus instrument operation data. A compact data logging system would facilitate data processing and would be applicable to all Shuttle payloads.

TECHNICAL PLAN:

OBJECTIVE: The objective is to develop a data monitor and accounting system which will provide in compact form all the necessary data to reconstruct the experiment operation.

APPROACH: Study typical payload requirements, Shuttle mission operations, and ground data processing requirements which will provide the necessary requirements for a Shuttle payload "flight recorder."

RESOURCE REQUIREMENTS:

MANPOWER: TBD

FACILITIES: TBD

FUNDING: TBD

TARGET SCHEDULE: Early Phase C

2.2 VERIFICATION

NUMBER: 2.2.1	PROPOSED SR&T TASK	DATE: 11/5/76

TITLE: GUIDELINES FOR SELECTION OF AMPS VERIFICATION PROGRAMS

STATUS:

- [ ] RESEARCH
- [ ] ADVANCED DEVELOPMENT
- [ ] ADVANCED TECHNOLOGY
- [X] SUPPORTING DEVELOPMENT

JUSTIFICATION: Many factors enter into the selection process of a verification program for AMPS flight hardware. Some of the factors are: cost, scientific return, nature of design and use, previous history and level of assembly. Additionally, subjective influences of personnel are factored into the selection process. It is desirable to mechanize the selection process through the application of guidelines, criteria or weighing factors to enable more equitable application of program resources to flight elements, consistent with their overall contributions and to reduce overall cost of verification.

TECHNICAL PLAN:

OBJECTIVE: The objective is to define guidelines and procedure for a selection process of verification programs for AMPS flight hardware.

APPROACH: The technical approach is to analyze the factors which enter into the selection of a verification program to establish their relative significance and contribution to flight assurance. Next, ranking order, weighing factors, guidelines and criteria and logic patterns will be established. Finally, sample cases will be worked against actual programs to validate the approach and procedure.

RESOURCE REQUIREMENTS:

MANPOWER: TBD

FACILITIES: None

FUNDING: TBD

TARGET SCHEDULE: Pre Phase C.

2.3 SYSTEMS ANALYSIS

NUMBER: 2.3.1	PROPOSED SR&T TASK	DATE: 11/5/76

TITLE: ELECTROMAGNETIC COMPATIBILITY

STATUS:

- [X] RESEARCH
- [ ] ADVANCED DEVELOPMENT
- [ ] ADVANCED TECHNOLOGY
- [ ] SUPPORTING DEVELOPMENT

JUSTIFICATION: A complete detailed electromagnetic compatibility analysis of the AMPS payload to insure effective operation of instruments and accomplishment of experiment objectives.

TECHNICAL PLAN:

OBJECTIVE: The objective is to perform a standard electromagnetic compatibility analysis of the AMPS payload.

APPROACH: The technical approach is to first complete the parameters (such as susceptibility, emission, etc) of each instrument. A worst case analysis is then performed using the defined AMPS configuration and all instruments active at one time. The experiment timelines are then factored into the analysis and resulting problem areas resolved through trade-offs.

RESOURCE REQUIREMENTS:

MANPOWER: TBD

FACILITIES: Computer Time, TBD

FUNDING: TBD

TARGET SCHEDULE: Task should begin prior to Phase C.

NUMBER: 2.3.2	PROPOSED SR&T TASK	DATE: 11/5/76

TITLE: METHODS TO OBTAIN ORIENTATION KNOWLEDGE FOR INSTRUMENTS.

STATUS:

- [X] RESEARCH
- [ ] ADVANCED DEVELOPMENT
- [ ] ADVANCED TECHNOLOGY
- [ ] SUPPORTING DEVELOPMENT

JUSTIFICATION: A number of AMPS instruments require knowledge of the relative orientation between the Shuttle velocity vector and the instrument optical axis to within 0.01 degree. The Shuttle inertial measurement unit (IMU) navigation base is located approximately 30 meters from the AMPS instruments in the payload bay and has an accuracy of approximately ± 0.5 degree. Offsets (IMU to instrument) are assumed to be approximately two degrees or greater. These offsets are due to structural misalignments, vehicle flexibility and thermal deformations and have not been defined. The result of these conditions is that the precise orientation knowledge required by some AMPS experiments may not be met.

TECHNICAL PLAN:

OBJECTIVE: The objective is to determine the method or methods necessary to insure that the orientation knowledge requirements of all AMPS instruments can be satisfied.

APPROACH: The technical approach involves a trade study. Three possible methods are:

a. Analytically determine the structural offset effects.
b. In-flight calibration technique to determine precise offset values (IMU to instrument). For example, during OFT flights.
c. Determine cost-effectiveness of installation of a separate IMU at the payload location.

RESOURCE REQUIREMENTS:

MANPOWER: TBD

FACILITIES: TBD

FUNDING: TBD

TARGET SCHEDULE: Task should begin early in Phase C.

NUMBER: 2.3.3	PROPOSED SR&T TASK	DATE: 11/5/76

TITLE: SPACECRAFT CHARGING AND NEUTRALIZATION MECHANISMS

STATUS:

- [X] RESEARCH
- [ ] ADVANCED DEVELOPMENT
- [ ] ADVANCED TECHNOLOGY
- [ ] SUPPORTING DEVELOPMENT

JUSTIFICATION: Analytical studies of the spacecraft voltage relative to the surrounding plasma indicate that operation of a high-current electron-beam generator from the payload bay will lead to Orbiter potentials of several thousand volts, unless an adequate return current is provided by special techniques. This can adversely affect the operation of the instrument. Uncertainties in the analytical models do not allow precise evaluation of anticipated spacecraft potentials. The non-conductive nature of the majority of the Orbiter's skin adds further complications to the analysis.

TECHNICAL PLAN:

OBJECTIVE: Experimental evaluation of the effects of electron beam operation on spacecraft potential relative to the surrounding plasma.

APPROACH: Operate a moderate-current electron-beam generator, starting with minimum beam current, while traversing regions of high free-electron density. Use sensitive instrumentation to monitor:

1. Plasma environment: electron/ion density, and neutral particle density.
2. Spacecraft potential relative to surrounding plasma (Langmuir probes, retarding potential analyzers, etc.)
3. Charge deposition on dielectric samples identical to Orbiter's thermal control coatings, for various "shadowing" conditions.

Carefully increase electron beam current while constantly monitoring spacecraft potential. The acquired data will provide understanding of spacecraft charging and neutralization mechanisms.

RESOURCE REQUIREMENTS:

MANPOWER: TBD

FACILITIES: TBD

FUNDING: TBD

TARGET SCHEDULE: Pre Phase C

NUMBER: 2.3.4	PROPOSED SR&T TASK	DATE: 11/5/76

TITLE: ORBITER/SPACELAB ENVIRONMENT DEFINITION

STATUS:

- ☐ RESEARCH
- ☐ ADVANCED DEVELOPMENT
- ☐ ADVANCED TECHNOLOGY
- ☒ SUPPORTING DEVELOPMENT

JUSTIFICATION: Many scientific experiments considered by the AMPS science working group require a knowledge of the background levels of EMI and gaseous/particulate contaminants induced by the Orbiter/Spacelab. To assist the definition of scientific experiments to be carried out in the near-Orbiter vicinity. A systematic determination of these levels, their spatial distribution and their time dependence is required.

TECHNICAL PLAN:

OBJECTIVE: (1) Determine contaminant cloud column densities and their spatial and temporal distributions; Determine contaminant deposition rates for payload bay and locally deployed instruments.

(2) Determine AC/DC background EMI levels originating from Orbiter/Spacelab systems during nominal orbital operations.

APPROACH: (1) Contamination. Apply Theoretical Contaminant Model developed by MMC.

(2) EMI - Develop Shuttle OFT measurement/test program.

RESOURCE REQUIREMENTS:

MANPOWER: TBD

FACILITIES: TBD

FUNDING: TBD

TARGET SCHEDULE: Pre Phase C

NUMBER: 2.3.5	PROPOSED SR&T TASK	DATE: 11/5/76

TITLE: EXPERIMENTER/COMPUTER DIALOGUE DEVELOPMENT

STATUS:

- [ ] RESEARCH
- [ ] ADVANCED DEVELOPMENT
- [ ] ADVANCED TECHNOLOGY
- [X] SUPPORTING DEVELOPMENT

JUSTIFICATION: An optimized experimenter/computer interface is a key element for accomplishing Spacelab payload scientific objectives. Early experimentation with various dialogue structures, which can be applied to various scientific disciplines, can minimize costly major changes later in the program. The most practical approach to dialogue development is simulation utilizing hardware and software closely resembling the actual flight system. This hardware/software is presently available at MMC.

TECHNICAL PLAN:

OBJECTIVE: To develop an optimized experimenter/computer dialogue consistent with typical S/L payload control and display requirements and S/L CDMS capability.

APPROACH:

(1) Define detailed C&D requirements for a typical Labcraft payload.
(2) Utilizing available simulation capability, implement the payload requirements using various alternative dialogue structures.
(3) Identify optimum dialogue structures consistent with S/L CDMS capabilities.
(4) Identify detailed dialogue software requirements.

RESOURCE REQUIREMENTS:

MANPOWER: TBD

FACILITIES: TBD

FUNDING: TBD

TARGET SCHEDULE: Pre Phase C

3. SUBSYSTEMS/DISCIPLINES

Table 3-1 summarizes the candidate SR&T tasks identified for the subsystems/disciplines category and individually discussed in this section.

SUBCATEGORY	TASK	SCHEDULE	
		PRE PHASE C	PHASE C
(3.1) Structural/ Mechanical	(3.1.1) Deployment/Ejection, and Capture/ Release Mechanisms.	X	
(3.2) Thermal	(3.2.1) Thermal Canister Technology	X	
(3.3) Support Subsystems	(3.3.1) DC Pulsed Power Supply and Energy Storage System.	X	
	(3.3.2) Analog/Video Data System	X	
(3.4) Pointing Subsystems	(3.4.1) Minaturized Pointing Mount (MPM) Isolation System.	X	
(3.5) Deployed Instrument Support	(3.5.1) Maneuverable Subsatellite Technology.	X	

TABLE 3.1 SUBSYSTEMS/DISCIPLINES SR&T TASKS

3.1 STRUCTURAL/MECHANICAL

NUMBER: 3.1.1	PROPOSED SR&T TASK	DATE: 11/5/76

TITLE: DEPLOYMENT/EJECTION, CAPTURE/RELEASE MECHANISMS

STATUS:

- [X] RESEARCH
- [ ] ADVANCED DEVELOPMENT
- [ ] ADVANCED TECHNOLOGY
- [ ] SUPPORTING DEVELOPMENT

JUSTIFICATION: The AMPS program identifies many situations where (a) instrument packages must be deployed and/or ejected from the payload bay with a specific ΔV orientation, and spin, (b) instruments within the payload are operated outside the payload bay envelope, thereby requiring emergency ejection capability in case of malfunction, and (c) a family of capture/release devices are needed to secure packages during launch, release for deployment, and capture and secure for return.

TECHNICAL PLAN:

OBJECTIVE: The objective is to determine the types of mechanisms that should be used on AMPS for deployment/ejection, emergency ejection, and capture/release.

APPROACH: The technical approach is to study the capabilities of available mechanisms to meet AMPS requirements. The range of ΔV requirements (0.1-10 meters/second) specified for the ejection mechanisms necessitate a determination if one or more types of mechanisms are required. Emergency ejection mechanisms and techniques must be defined to insure that AMPS instruments can be ejected if they malfunction and physically obstruct closure of the payload bay doors. A family of capture/release mechanisms could be sized to provide this necessity to various packages and payloads.

RESOURCE REQUIREMENTS:

MANPOWER: TBD

FACILITIES: TBD

FUNDING: TBD

TARGET SCHEDULE: This task should begin prior to Phase C.

3.2 THERMAL

NUMBER: 3.2.1	PROPOSED SR&T TASK	DATE: 11/5/76

TITLE:

STATUS:

- [ ] RESEARCH
- [ ] ADVANCED DEVELOPMENT
- [ ] ADVANCED TECHNOLOGY
- [x] SUPPORTING DEVELOPMENT

JUSTIFICATION: Several AMPS instruments must be maintained within $\pm 5^{\circ}C$. A viable thermal design approach, currently being studied uses variable conductance heat pipes. This design should provide adequate thermal control but is relatively expensive. Other, lower-cost approaches such as a cold-biased design should be investigated to determine thermal performance for the AMPS configurations and missions.

TECHNICAL PLAN:

OBJECTIVE: To determine thermal performance for several canister thermal design approaches, for the AMPS configuration.

APPROACH: Existing thermal math models for the AMPS configuration will be used. The advantages/disadvantages of each design will be assessed and recommendations made.

RESOURCE REQUIREMENTS:

MANPOWER: TBD

FACILITIES: TBD

FUNDING: TBD

TARGET SCHEDULE: Pre Phase C

3.3 SUPPORT SUBSYSTEMS

NUMBER: 3.3.1	PROPOSED SR&T TASK	DATE: 11/5/76

TITLE: DC PULSED POWER SUPPLY AND ENERGY STORAGE SYSTEM

STATUS:

- [ ] RESEARCH
- [ ] ADVANCED DEVELOPMENT
- [X] ADVANCED TECHNOLOGY
- [ ] SUPPORTING DEVELOPMENT

JUSTIFICATION: The AMPS program instruments require high power at high voltage for short durations during the scientific investigations. To satisfy these requirements a DC pulsed power supply and an energy storage system capable of storing several mega-joules of energy are required. Such power supplies and energy storage systems are not available off-the-shelf and represent long-lead items to the program.

TECHNICAL PLAN:

OBJECTIVE: The objective is to identify the hardware requirements for both the DC pulsed power supply and the energy storage system to permit preliminary design and costing of the system.

APPROACH: The approach is to analyze the power requirements and determine the magnitudes of the voltage, stored energy and power required. The repetition rate of the DC pulses will be determined which in turn defines charge rates and energy requirements from the prime power supply. Breadboard testing will then be accomplished to define the preliminary hardware design and permit cost and schedule analysis to be accomplished.

RESOURCE REQUIREMENTS:

MANPOWER: TBD

FACILITIES: TBD

FUNDING: TBD

TARGET SCHEDULE: This task should begin prior to Phase C.

NUMBER: 3.3.2	PROPOSED SR&T TASK	DATE: 11/5/76

TITLE: ANALOG/VIDEO DATA SYSTEM

STATUS:

- [ ] RESEARCH
- [x] ADVANCED DEVELOPMENT
- [ ] ADVANCED TECHNOLOGY
- [ ] SUPPORTING DEVELOPMENT

JUSTIFICATION: The Spacelab System does not provide for processing of analog/video data. Many Shuttle payloads have such requirements. A common system with modular flexibility can provide for a low cost system applicable to many payloads.

TECHNICAL PLAN:

OBJECTIVE: The objective is to develop a modular and flexible analog/video system which can be used by many payloads. Flexibility will include the feasibility of using NIM/CAMAC hardware which is presently used in ground laboratories.

APPROACH: The approach is to evaluate Shuttle payload requirements, control and display requirements, crew operation requirements and develop a breadboard design using ground commercial equipment.

RESOURCE REQUIREMENTS:

MANPOWER: TBD

FACILITIES: TBD

FUNDING: TBD

TARGET SCHEDULE: Pre Phase C

3.4 POINTING SUBSYSTEMS

NUMBER: 3.4.1	PROPOSED SR&T TASK	DATE: 11/5/76

TITLE: MINIATURIZED POINTING MOUNT (MPM) ISOLATION SYSTEM

STATUS:

- [X] RESEARCH
- [ ] ADVANCED DEVELOPMENT
- [ ] ADVANCED TECHNOLOGY
- [ ] SUPPORTING DEVELOPMENT

JUSTIFICATION: Slewing requirements for various MPM-mounted instruments require a dedicated design of the MPM isolation system in order to maintain pedestal motions and isolator elongations within tolerable limits and still meet the pointing stability requirements. For example, earth fixed point tracking requires a stiffer suspension system than that for stellar tracking.

TECHNICAL PLAN:

OBJECTIVE: For various suspension characteristics (stiffness and damping) of the isolation system, determine whether the MPM can meet the pointing stability requirements of the instrument.

APPROACH: Detail examination of the MPM-mounted instrument(s) to determine an optimum design of the suspension characteristics. Establish a number of design implementations, each dedicated to a class of instruments (i.e., earth pointing, sun, stellar, etc.) Determine feasibility of varying isolator characteristics while on-orbit to accommodate individual instrument requirements.

RESOURCE REQUIREMENTS:

MANPOWER: TBD

FACILITIES: TBD

FUNDING: TBD

TARGET SCHEDULE: Pre Phase C

3.5 DEPLOYED INSTRUMENT SUPPORT

NUMBER: 3.5.1	PROPOSED SR&T TASK	DATE: 11/5/76

TITLE: MANEUVERABLE SUBSATELLITE TECHNOLOGY

STATUS:

- [ ] RESEARCH
- [ ] ADVANCED DEVELOPMENT
- [ ] ADVANCED TECHNOLOGY
- [X] SUPPORTING DEVELOPMENT

JUSTIFICATION: The AMPS program identifies several experiments which require deployment of instruments and modules beyond the range of the Shuttle RMS. For these experiments the baseline AMPS configuration defines free flying satellites which are ejected from the Orbiter. An attractive alternative to this approach is to use a recoverable, maneuverable subsatellite. Several technical areas require research and development so as to minimize the risk in developing a new maneuverable subsatellite or in modifying an existing satellite.

TECHNICAL PLAN:

OBJECTIVE: To provide supporting development in several areas, done in parallel to the AMPS program.

APPROACH: Develop hardware and/or methods and techniques for (1) rendezvous and recovery of a subsatellite by the Orbiter, (2) collision avoidance by the subsatellite, (3) evaluating the effects of Orbiter and subsatellite thruster plume pressures, and (4) man-machine interactions during subsatellite control.

RESOURCE REQUIREMENTS:

MANPOWER: TBD

FACILITIES: TBD

FUNDING: TBD

TARGET SCHEDULE: These tasks should begin early in Phase C of AMPS.

4. INSTRUMENTS

Table 4.1 summarizes the candidate SR&T tasks identified for the instruments category and individually discussed in this section.

SUBCATEGORY	TASK	SCHEDULE	
		PRE PHASE C	PHASE C
(4.1) Active Instruments	(4.1.1) Gas/Chemical Release Module Technology.	X	
(4.2) Passive Optical Instruments	(4.2.1) OBIPS Sun Shade Design	X	
	(4.2.2) Cryogenic Technology	X	
	(4.2.3) Contamination Tolerant Instrument Design Concepts.	X	
(4.3) Passive Plasma Instruments	(No entry)		

TABLE 4.1 INSTRUMENTS SR&T TASKS

4.1 ACTIVE INSTRUMENTS

NUMBER: 4.1.1	PROPOSED SR&T TASK	DATE: 11/5/76

TITLE: GAS/CHEMICAL RELEASE MODULE TECHNOLOGY

STATUS:

- [ ] RESEARCH
- [ ] ADVANCED DEVELOPMENT
- [X] ADVANCED TECHNOLOGY
- [ ] SUPPORTING DEVELOPMENT

JUSTIFICATION: The active perturbation type experiments proposed for the AMPS program place a heavy emphasis on the use of massive gas and chemical releases. There are a large number of potential safety hazards implicit in performing these experiments such as deployment of the release modules, large high pressure gas tanks, rapid release systems, thermite burner canisters, and shaped charges. There is no precedent experience for carrying out this type of operation from a manned spacecraft. Detailed safety assessments are required before these experiment concepts can proceed on a firm basis.

TECHNICAL PLAN:

OBJECTIVE: To develop design approaches for the required hardware and operations such that safety assessments can be made of the experiment concepts.

APPROACH: Develop design concepts to a level adequate to support safety evaluations. These concepts should be developed for each of the major release systems contemplated for the early AMPS flights.

RESOURCE REQUIREMENTS:

MANPOWER: TBD

FACILITIES: TBD

FUNDING: TBD

TARGET SCHEDULE: Prior to Phase C

4.2 PASSIVE OPTICAL INSTRUMENTS

NUMBER: 4.2.1	PROPOSED SR&T TASK	DATE: 11/5/76

TITLE: OPTICAL BAND IMAGER AND PHOTOMETER SYSTEM (OBIPS) SUN SHADE DESIGN

STATUS:

- [ ] RESEARCH
- [ ] ADVANCED DEVELOPMENT
- [X] ADVANCED TECHNOLOGY
- [ ] SUPPORTING DEVELOPMENT

JUSTIFICATION: OBIPS requirements for isolation from interfering sunlight is very stringent and cannot be satisfied by standard sun shade designs. The non-circular configuration and performance levels required of the OBIPS sun shade may require an advance in the state-of-the-art.

TECHNICAL PLAN:

OBJECTIVE: The objective is to design a sunshade that can meet the performance specifications at the lowest possible cost.

APPROACH: The technical approach is to review existing sunshade designs and modify if possible. It may be found that a new design is required, perhaps a deployable sunshade or some other advance in the state-of-the-art.

RESOURCE REQUIREMENTS:

MANPOWER: TBD

FACILITIES: TBD

FUNDING: TBD

TARGET SCHEDULE: This task should begin prior to Phase C.

NUMBER: 4.2.2	PROPOSED SR&T TASK	DATE: 11/5/75

TITLE: CRYOGENIC TECHNOLOGY

STATUS:

- [ ] RESEARCH
- [ ] ADVANCED DEVELOPMENT
- [ ] ADVANCED TECHNOLOGY
- [X] SUPPORTING DEVELOPMENT

JUSTIFICATION: Several AMPS instruments require cooling to cryogenic temperatures both for the instrument telescope walls and detectors. These instruments are mounted on pointing platforms and to avoid the transfer of cryogens across gimbals an open loop, stored cryogen systems, is most viable. The size of the AMPS instruments are greater than current open loop systems. It must be determined if current design approaches are adequate. A particular area of interest is cryogen charging techniques.

TECHNICAL PLAN:

OBJECTIVE: The objective is to determine if current cryogenic technology can be used for the larger AMPS cryogenic instruments.

APPROACH: The technical approach is to study current cryogenic equipment and techniques in reference to the AMPS cryogenic requirements. Problem areas will be identified and alternate solutions or trade-offs recommended.

RESOURCE REQUIREMENTS:

MANPOWER: TBD

FACILITIES: TBD

FUNDING: TBD

TARGET SCHEDULE: This task should begin prior to Phase C

NUMBER: 4.2.3	PROPOSED SR&T TASK	DATE: 11/5/76

TITLE: CONTAMINATION TOLERANT INSTRUMENT DESIGN CONCEPTS.

STATUS:

- ☐ RESEARCH
- ☐ ADVANCED DEVELOPMENT
- ☐ ADVANCED TECHNOLOGY
- ☒ SUPPORTING DEVELOPMENT

JUSTIFICATION: The induced contamination environment of the Shuttle/Spacelab can be predicted for various operating conditions by means of existing NASA programs. Past experience has shown that optical instruments (particularly those operating in the UV and XUV spectral regions) will be subject to significant performance degradation if appropriate design and/or operational precautions are not taken.

TECHNICAL PLAN:

OBJECTIVE: To develop a set of design guidelines for instrument developers such that instruments can be made as tolerant of spacecraft induced contamination as possible.

APPROACH: Appropriate design concepts would be developed for each type of instrument proposed for Labcraft flights. Some of these concepts are:

(1) Use of protective covers and associated deployment mechanisms
(2) Line-of-sight impingement shields
(3) Purge gas flow systems
(4) Automated change out of elements

RESOURCE REQUIREMENTS:

MANPOWER: TBD

FACILITIES: TBD

FUNDING: TBD

TARGET SCHEDULE: Prior to Phase C as required information for Experimenters.

4.3 PASSIVE PLASMA INSTRUMENTS

(No entry)

5. SCIENCE SUPPORT

Table 5.1 summarizes the candidate SR&T tasks identified for the science support category and individually discussed in this section.

SUBCATEGORY	TASK		SCHEDULE	
			PRE PHASE C	PHASE C
(5.1) Atmospheric Physics	(5.1.1)	Calibration Procedures and Techniques for absolute radiometry measurements.		X
	(5.1.2)	Theoretical Modeling of Atmospheric Dynamics/Photochemistry.		X
(5.2) Magneto-spheric and Plasma Physics	(5.2.1)	Theoretical Modeling and Experimentation to Support AMPS Experiment Definition.		X

TABLE 5.1 SCIENCE SR&T TASKS

5.1 ATMOSPHERIC PHYSICS

NUMBER: 5.1.1	PROPOSED SR&T TASK	DATE: 5/14/76

TITLE: CALIBRATION PROCEDURES AND TECHNIQUES FOR ABSOLUTE RADIOMETRY MEASUREMENTS

STATUS:

- [ ] RESEARCH
- [ ] ADVANCED DEVELOPMENT
- [X] ADVANCED TECHNOLOGY
- [ ] SUPPORTING DEVELOPMENT

JUSTIFICATION: Many AMPS experiments require simultaneous measurements from AMPS instruments, satellites, and/or ground stations, such as absolute radiometry measurements especially in the XUV/UV regions. Calibration techniques and procedures are required to allow accurate comparison and interpretation of scientific data obtained from more than one source.

TECHNICAL PLAN:

OBJECTIVE: The study objective is to prepare calibration procedures to insure accuracy of scientific data obtained from more than one source.

APPROACH: The technical approach will require research of existing techniques used on other NASA/DOD programs for applicability to AMPS experiments.

RESOURCE REQUIREMENTS:

MANPOWER: TBD

FACILITIES: TBD

FUNDING: TBD

TARGET SCHEDULE: The SR&T tasks should commence during Phase C. concentrating on early flight requirements for this type of calibration. Task completion should be during Phase C.

NUMBER: 5.1.2	PROPOSED SR&T TASK	DATE: 11/5/76

TITLE: THEORETICAL MODELING OF ATMOSPHERIC DYNAMICS/PHOTOCHEMISTRY

STATUS:

- [X] RESEARCH
- [ ] ADVANCED DEVELOPMENT
- [ ] ADVANCED TECHNOLOGY
- [ ] SUPPORTING DEVELOPMENT

JUSTIFICATION: Basic theoretical scientific work is required to more precisely define the AMPS experiment objectives in this area. With this increased scientific (theoretical) knowledge of atmospheric behavior and parameters a better, systematic experiment program can be defined.

TECHNICAL PLAN:

OBJECTIVE: The objective is to develop a theoretic model describing atmospheric dynamics and photochemistry.

APPROACH: The technical approach is a review of current and past work in this area and development of theoretical model describing expected atmospheric behavior.

RESOURCE REQUIREMENTS:

MANPOWER: TBD

FACILITIES: Computer, TBD

FUNDING: TBD

TARGET SCHEDULE: The task should be completed during Phase C.

5.2 MAGNETOSPHERIC AND PLASMA PHYSICS

NUMBER: 5.2.1	PROPOSED SR&T TASK	DATE: 11/5/76

TITLE: THEORETICAL MODELING AND EXPERIMENTATION TO SUPPORT AMPS EXPERIMENT DEFINITION

STATUS:

- [X] RESEARCH
- [ ] ADVANCED DEVELOPMENT
- [ ] ADVANCED TECHNOLOGY
- [ ] SUPPORTING DEVELOPMENT

JUSTIFICATION: Increase scientific knowledge in the areas of magnetospheric/ionospheric coupling, ionospheric properties, plasma flow, and particle interactions, would result in better definition of AMPS experiment objectives, thereby precluding any possibility of unnecessary or unproductive use of AMPS mission time.

TECHNICAL PLAN:

OBJECTIVE: The study objective is to develop a theoretical model of ionospheric and magnetospheric parameters.

APPROACH: The technical approach is a combination of research, study, and experimentation. The experimentation is being done or can be done using existing balloon and sounding rocket programs.

RESOURCE REQUIREMENTS:

MANPOWER: TBD

FACILITIES: TBD

FUNDING: TBD

TARGET SCHEDULE: This task should be completed during Phase C.